

**United States Court of Appeals
for the Federal Circuit**

APPLE INC.,
Appellant

v.

ANDREA ELECTRONICS CORPORATION,
Appellee

2018-2382, 2018-2383

Appeals from the United States Patent and Trademark Office, Patent Trial and Appeal Board in Nos. IPR2017-00626, IPR2017-00627.

Decided: February 7, 2020

JEFFREY PAUL KUSHAN, Sidley Austin LLP, Washington, DC, argued for appellant. Also represented by THOMAS ANTHONY BROUGHAN, III, CHRISTIN SULLIVAN MILLER.

WILLIAM D. BELANGER, Pepper Hamilton LLP, Boston, MA, argued for appellee. Also represented by BRADLEY THOMAS LENNIE, GOUTAM PATNAIK, Washington, DC.

Before DYK, PLAGER, and STOLL, *Circuit Judges*.
PLAGER, *Circuit Judge*.

The patent at issue in this appeal, U.S. Patent No. 6,363,345 (“the ’345 patent”), relates to certain aspects of digital audio processing. On September 19, 2016, Andrea Electronics Corp. (“Andrea or Appellee”), assignee of the ’345 patent, sued Apple, Inc. (“Apple or Appellant”) for infringement of the ’345 patent in the Eastern District of New York. J.A. 1151–70. On January 9, 2017, Appellant Apple filed two *inter partes* review (“IPR”) petitions—the ’626 IPR and ’627 IPR—with the U.S. Patent and Trademark Office, challenging the validity of claims 1–25 and 38–47 of the patent.

The Patent Trial and Appeal Board (“Board”) instituted review of both petitions and consolidated the proceedings. In its ’626 IPR Final Written Decision, the Board concluded that, in light of the prior art cited by Apple, all challenged claims except claims 4–11 and 39–47 of the ’345 patent are unpatentable. In the course of reaching that conclusion, the Board declined to consider certain arguments in Apple’s ’626 IPR reply brief applicable to claims 6–9 on the ground that Apple was raising new arguments in its reply brief that were not entitled to consideration at that late stage in the proceedings.

In its ’627 IPR Final Written Decision, the Board concluded that, in light of other cited art, all challenged claims of the ’345 patent except claims 6–9, 17–20, 24, and 47 are unpatentable. In reaching that conclusion, the Board adopted a claim construction of the claim term “periodically” in favor of Andrea that supported its analysis. Between the two IPRs, the Board held that all challenged claims except claims 6–9 are unpatentable.

With regard to the ’626 IPR Board decision, Apple appeals the Board’s conclusion that claims 6–9 are surviving claims, arguing that had the Board properly considered its reply brief arguments, that would not have been the outcome. With regard to the ’627 IPR Board decision, Apple argues that the Board erred in its conclusion that, based on

the prior art cited, claims 6–9 are not unpatentable as either anticipated or obvious.

With respect to the '626 IPR, for the reasons we shall explain, we conclude that the Board erred in refusing to consider Apple's reply arguments. Accordingly, we vacate the Board's decision in the '626 IPR, and remand for reconsideration of Apple's reply brief arguments addressing the indicated prior art reference.

With respect to the '627 IPR, we find that the Board's decision with regard to the validity of the patent claims in its '627 IPR Final Written Decision was correctly reached. We therefore affirm the Board with respect to the '627 IPR.

I. BACKGROUND

A. Digital Audio Processing

Because an understanding of the issues and our disposition of them require some familiarity with the technology of sound and digital audio processing, we begin with that. Sound is the physical vibrations of a medium, such as air. These vibrations are often depicted in the form of a sinusoidal wave, a "sine wave," with time on the x-axis (horizontal), and the amplitude of the signal (roughly, volume) on the y-axis (vertical).



J.A. 833.

In addition to the amplitude, the frequency (cycles per period of time) of a sound wave is a particularly relevant

factor for human hearing. While amplitude roughly corresponds to volume, frequency corresponds to the pitch of the sound.

Music and speech are generally comprised of sound at different frequencies (e.g., a musical chord consists of several notes played simultaneously). When multiple notes are played at the same time, the graphical representation of the resulting signal may look different from a simple sine wave:



J.A. 836. The resulting graph is a composite of several different sine waves, each corresponding to an individual frequency and amplitude. To determine which frequencies make up the signal, the signal can be converted to the frequency domain via a well-known mathematical formula called a “Fourier transform.”

Digital signal processing frequently uses Fourier transforms to convert sounds between the time domain and frequency domain because it is computationally easier to make certain modifications to the signal in the frequency domain than in the time domain. This conversion to the frequency domain results in a histogram, in which the signal is divided into “frequency bins” and each bin corresponds to one of the frequencies present in the signal. The magnitude of a particular frequency is represented on the y-axis.

B. The '345 Patent

The patent at issue, the '345 patent, describes a method, system, and apparatus that utilizes Fourier transforms and a process known as “spectral subtraction” for noise cancellation and reduction purposes. The disclosed system converts an audio signal to the frequency domain via Fourier transforms, sets separate thresholds for each “frequency bin” in order to distinguish the background noise, and then employs “spectral subtraction” to remove ambient noise without affecting speech and its characteristics. '345 patent, col. 6 ll. 10–13.

In order to determine the appropriate threshold for each frequency bin, the system sets two minimum values, which are described as a “future minimum” and a “current minimum.” '345 patent, col. 6 ll. 23–41. At predetermined time intervals (e.g., every five seconds), the future minimum value is initialized as the value of the current magnitude of the signal. '345 patent, col. 6 ll. 24–28. Over that time interval, the future minimum is compared with the current magnitude value of the signal. If the observed magnitude is less than the value of the future minimum, then the future minimum is set equal to that newly observed lower value. '345 patent, col. 6 ll. 24–32.

At the start of each time interval, the current minimum is set as the value of the future minimum that was determined over the previous time interval. '345 patent, col. 6 ll. 34–38. The current minimum value then follows the minimum value of the signal over the next time interval by comparing its value with the current magnitude value. '345 patent, col. 6 ll. 34–38. The final current minimum value is used to calculate the adaptive threshold.

This adaptive threshold is used in a process known as “spectral subtraction,” in which the value of the estimated “noise magnitude” is subtracted from the current magnitude value of the bin. The result is a cleaner signal with some of the noise removed.

C. The Claims at Issue

Claims 6–9 of the ’345 patent are the only claims at issue in this appeal. Claims 6–9 depend from claim 5, which depends from claim 4, which depends from claim 1:

1. An apparatus for cancelling noise, comprising:

An input for inputting an audio signal which includes a noise signal;

A frequency spectrum generator for generating the frequency spectrum of said audio signal thereby generating frequency bins of said audio signal; and

A threshold detector for setting a threshold for each frequency bin using a noise estimation process and for detecting for each frequency bin whether the magnitude of the frequency bin is less than the corresponding threshold, thereby detecting the position of noise elements for each frequency bin.

’345 patent, col. 9 ll. 34–46 (emphasis added).

Claim 4 adds features to the threshold detector, noting that the threshold detector “sets the threshold for each frequency bin in accordance with a current minimum value of the magnitude of the corresponding frequency bin; said current minimum value being derived in accordance with a future minimum value of the magnitude of the corresponding frequency bin.” ’345 patent, col. 9 ll. 54–60.

Claim 5 adds that the “future minimum value is determined as the minimum value of the magnitude of the corresponding frequency bin within a predetermined period of time.” Thus claims 6–9 depend ultimately from claim 5, and place specific limits on how the “current minimum value” or “future minimum value” are determined.

Claim 6 recites:

The apparatus according to claim 5, wherein said current minimum value is set to said future minimum value periodically.

'345 patent, col. 9, ll. 65–67.

Claim 7 recites:

The apparatus according to claim 6, wherein said future minimum value is replaced with the current magnitude value when said future minimum value is greater than said current magnitude value.

'345 patent, col. 10, ll. 1–4.

Claim 8 recites:

The apparatus according to claim 6, wherein said current minimum value is replaced with the current magnitude value when said current minimum value is greater than said current magnitude value.

'345 patent, col. 10, ll. 5–8.

Claim 9 recites:

The apparatus according to claim 5, wherein said future minimum value is set to a current magnitude value periodically; said current-magnitude value being the value of the magnitude of the corresponding frequency bin.

'345 patent, col. 10, ll. 9–12.

II. The Issues

A. The '626 and '627 IPR Proceedings

As noted, Apple filed its two IPR petitions—the '626 IPR and the '627 IPR—challenging claims 1–25 and 38–47 of the '345 patent. Relevant to this appeal, Apple alleged

that the challenged claims would have been anticipated or obvious in light of three pieces of prior art.

In its '626 IPR petition, Apple alleged that claims 6–9 of the '345 patent would have been obvious over Hirsch and Martin. Apple alleged in its '627 IPR petition that claims 6–9 are anticipated by Helf or would have been obvious over Helf and Martin. The Board instituted review on all challenged claims and grounds raised in both petitions and consolidated the two proceedings.

The three pieces of prior art are:

- a. Rainer Martin, An Efficient Algorithm to Estimate the Instantaneous SNR of Speech Signals (1993) (“Martin”)

Martin describes an algorithm for “instantaneous[ly]” estimating the “signal-to-noise” ratio of speech signals. J.A. 924. The Martin algorithm can be split into three major parts: (1) computation of a smoothed short time power estimate $\bar{P}_x(i)$ of signal $x(i)$; (2) computation of the noise power estimate $P_n(i)$; and (3) computation of the estimated signal-to-noise ratio of signal $x(i)$ at time i , $SNR_x(i)$. J.A. 924–25. The algorithm tracks varying noise power levels during speech activity over a defined number (“ L ”) of digital samples, wherein each set of L samples corresponds to a portion of the signal, a “window,” e.g., 0.625 seconds. J.A. 925. Each window of length L is further divided into additional windows, or sub-windows (“ W ”). J.A. 925.

One important consideration of the algorithm is whether the signal’s power is monotonically increasing for a given period of time—that is, whether “the minimum power of the last W windows . . . is monotonically increasing” for that period of time. J.A. 925. Martin requires at least two sub-windows ($W \geq 2$) in order to determine whether a signal’s power level is monotonically increasing. J.A. 15. Under Martin’s approach, a scheme with no sub-windows (*i.e.*, $W = 1$) cannot be used to determine whether the signal is monotonically increasing.

b. H.G. Hirsch & C. Ehrlicher, Noise Estimation Techniques for Robust Speech Recognition (1995) (“Hirsch”)

The Hirsch reference describes improvements to the spectral subtraction process and provides algorithms for estimating the noise level of an audio signal. J.A. 920–21. Like the ’345 patent, one of the Hirsch algorithms utilize an “adaptive threshold” for each frequency bin of the audio signal to distinguish between noise and speech. Hirsch explains that one advantage of using an adaptive threshold is that the methods estimate the noise levels “without an explicit speech pause detection.” J.A. 920. Hirsch refers to Martin as a “known” approach “to avoid the problem of speech pause detection and to estimate the noise characteristics just from a past segment of noisy speech.” J.A. 920, 923.

c. U.S. Patent No. 5,550,924 (“Helf”)

Helf describes a system for “reducing the background noise of an input audio signal.” J.A. 964, col. 1, ll. 39–40. Helf’s claimed system similarly utilizes Fourier transforms to convert an audio signal into the frequency domain before calculating the estimated noise in each frequency bin. J.A. 964, col. 1, ll. 54–61.

Helf has two approaches for estimating the background noise in an audio signal: (1) a “stationary estimator” to compute a noise estimate, “ B_k ”; and (2) a “running minimum estimator” to compute a noise estimate “ M_k .” Helf explains that the first approach, the method utilizing a stationary estimator, is more accurate but requires one second intervals of solely background noise. J.A. 966, col. 6, ll. 33–39.

The second approach, the method utilizing a running minimum estimator, is less accurate but develops background noise estimates in ten seconds under any conditions. J.A. 966, col. 6, ll. 37–39. This approach calculates the differences between the noise estimate, M_k , and

previous background noise estimates according to a formula. J.A. 967, col. 8, ll. 54–57. If the overall difference exceeds a threshold, then M_k is used as the new background noise estimate. This approach will only occur if two steps are met: (1) the noise estimates from the stationary estimator have not been updated for more than ten seconds; and (2) when the calculated value “D” of the Helf patent exceeds a particular threshold. J.A. 967, col. 8, ll. 33–60.

1. The '626 IPR

In its '626 IPR petition, Apple argued that Martin discloses the “current minimum” and “future minimum” limitations required by claims 6–9. According to Apple, Martin’s “noise floor estimation process” algorithm uses a “current minimum,” $P_n(i)$, and a “future minimum,” P_{Mmin} , to track the minimum signal power, $P_x(i)$, during a predetermined period. Apple asserted that a person having ordinary skill in the art (a “POSA”) would have understood that Martin’s algorithm could also be used to track the “magnitude” of the noise signal, as required by claims 6–9 of the '345 patent. As an example, Apple’s expert witness, Dr. Hochwald, derived certain estimated noise floor values, $P_n(i)$, and minimum observed noise power values, P_{Mmin} , by inputting certain variables. In this example, Dr. Hochwald assumed that there are no sub-windows ($W = 1$). J.A. 130–131.

In its Patent Owner Response, Andrea argued that Martin does not disclose a “future minimum,” as required by claims 6–9. In support of this position, Andrea explained that in both the “monotonically increasing” and the “non-monotonically increasing” applications of the algorithm, there is no future minimum and similarly utilized an example of the algorithm to demonstrate its point. J.A. 280–91. Unlike Dr. Hochwald, however, Andrea’s expert witness, Dr. Douglas, applied Martin’s algorithm in the context of multiple sub-windows ($W \geq 2$) because a

determination of whether a signal's power is monotonically increasing over window length L requires at least two sub-windows. J.A. 925.

Apple rebutted Andrea's arguments on reply, responding that Andrea mischaracterized Martin and read non-existent limitations into the claims. First, Apple argued that where Martin is configured to use one sub-window ($W = 1$), it is not necessary to determine whether the sound is monotonically increasing. J.A. 463. Therefore, when there is only one sub-window, Martin discloses a future minimum because the $P_n(i)$ value (current minimum) is set to the same P_{Mmin} value (future minimum), irrespective of which update equation is used. J.A. 464.

Apple further argued that even under Andrea's "multiple-sub-windows" application of the algorithm, the Martin algorithm still teaches a future minimum. J.A. 465–68. Apple contended that the claims do not specify the period over which the future minimum must be calculated, and as a result, in a scenario where a signal is monotonically increasing, Martin satisfies the claims. J.A. 467. Apple argued that in cases where a signal is not monotonically increasing, the claims do not prohibit calculating the future minimum over a particular data window or using the minimum of a previous sub-window as the "future minimum."

Apple submitted a reply expert declaration to support its analysis of the Martin algorithm in the context of multiple sub-windows. Andrea subsequently deposed Apple's expert witness for a second time but did not request authorization to file a sur-reply or move to strike any portion of Apple's reply briefing. J.A. 252.

During oral argument, the Board questioned whether Apple's reply raised new arguments that were not otherwise discussed in the petition. J.A. 536–38 (13:5–15:18). In response, Apple pointed to the two pages in its petition addressing how the Martin algorithm teaches a noise floor estimation process that uses a "current minimum" and a

“future minimum” to track the minimum signal power during a predetermined period. J.A. 537 (14:3–21), J.A. 128–29.

2. The '627 IPR

In its '627 IPR petition, Apple argued that Helf discloses the “periodically” limitation of claims 6–9. Claims 6–9 recite a current and future minimum, wherein the two values are set “periodically.” In proposing a construction for the term, Apple relied on a definition provided by Webster’s Dictionary that defined “periodically” as “1: at regular intervals of time” and “2: from time to time.” J.A. 2483. Apple took the position that both of these definitions apply to the term “periodically” in the context of the '345 patent.

With respect to its anticipation and obviousness arguments, Apple stated that Helf discloses a current minimum and future minimum that is set “periodically,” or “from time to time.” Reasoning that Helf’s running minimum estimator sets the background noise estimate, N_k , (current minimum) to the running minimum estimate, M_k , (future minimum) whenever the difference between these values exceeds a threshold, Apple argued that this setting occurs “periodically,” or “from time to time.” J.A. 2483.

Alternatively, Apple contended that Helf discloses the “periodically” limitation because, in cases where the stationary estimator approach is not available (*e.g.*, the audio signal continuously contains speech without any pauses), the current background noise estimate approach is set to the minimum estimate, M_k , 10 seconds after the system starts. J.A. 2483. Apple also argued that a POSA would have modified Helf’s system, in light of Martin, to update the current and future minimum values “at regular intervals of time.” Appellant Br. 62–63.

In response, Andrea argued that the term “periodically” should only be construed as “occurring at regular intervals of time,” and not “from time to time.” J.A. 2614. In

support of its position, Andrea explained that the '345 patent written description's use of the term is only consistent with the first definition of "periodically." J.A. 2615. For example, the written description only references the term once, when describing an embodiment of the invention, wherein "[t]he future and current minimum values are calculated continuously and initiated periodically, for example, every 5 seconds as determined in step 724 and control is advanced to steps 722 and 726 wherein the new future and current minimum are calculated." '345 patent, col. 8 ll.36–40.

Based on its proposed construction of "periodically," Andrea argued that Helf does not disclose the "periodically" limitation because Helf's running minimum estimator does not set the current background noise estimate to the minimum estimate M_k at regular intervals of time. *See* J.A. 2632.

3. The Board's Final Written Decisions

In its Final Written Decisions for the '626 and '627 IPRs, the Board concluded that Apple had demonstrated that claims 1–5, 10–25, and 38–47 of the '345 patent are unpatentable. The Board held, however, that in neither of the two IPRs had Apple demonstrated that claims 6–9 of the '345 patent are unpatentable.

With respect to the '626 IPR, the Board concluded that a POSA would not have found it obvious to modify Hirsch's system, based on a scenario from Martin where there are no sub-windows ($W = 1$). Importantly, the Board refused to consider Apple's responsive arguments in its reply where it considered the Martin algorithm with multiple sub-windows ($W \geq 2$), finding that these arguments raised a new theory of unpatentability for the first time in its reply brief.

With respect to the '627 IPR, the Board adopted Andrea's proposed claim construction for "periodically" and construed the term to mean "at regular intervals of time."

Based on this construction, the Board concluded that Apple failed to prove that Helf, alone or in combination with Martin, discloses the “periodically” limitation as required by claims 6–9 of the ’345 patent.

III. DISCUSSION

A. Was the Board Correct When It Determined That Apple’s Reply Brief in the ’626 IPR Raised a New Theory of Unpatentability?

The Board’s determinations that a party exceeded the scope of a proper reply are reviewed for abuse of discretion. *See Ericsson Inc. v. Intellectual Ventures I LLC*, 901 F.3d 1374, 1379 (Fed. Cir. 2018); *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359 (Fed. Cir. 2016). Apple contends that the Board abused its discretion by refusing to consider arguments and evidence that Apple advanced in its ’626 IPR reply brief.

“It is of the utmost importance that petitioners in the IPR proceedings adhere to the requirement that the initial petition identify ‘with particularity’ the ‘evidence that supports the grounds for the challenge to each claim.’” *See Intelligent Bio-Sys.*, 821 F.3d at 1369 (citing 35 U.S.C. § 312(a)(3)). And “[a] reply may only respond to arguments raised in the corresponding opposition, patent owner preliminary response, or patent owner response.” 37 C.F.R. § 42.23(b). Therefore, in determining whether Apple appropriately advanced its arguments regarding the application of the Martin algorithm with multiple sub-windows ($W \geq 2$), we must consider: whether the petitioner’s reply brief is responsive to arguments originally raised in its petition; or whether the reply arguments are responsive to arguments raised in the patent owner’s response brief.

Andrea contends that the Board correctly precluded Apple’s arguments applying the Martin algorithm with multiple sub-windows because Apple’s ’626 IPR petition was “intentionally” premised on a scenario in which there

were no sub-windows ($W = 1$). Andrea argues that Apple's multiple sub-window discussion is a "new theory of unpatentability," particularly because the accompanying expert declaration to Apple's petition relied solely upon a scenario wherein $W = 1$.

We disagree. Apple's legal ground did not change in its reply—its reply still asserted that claims 6–9 would have been obvious over Hirsch and Martin. Moreover, Apple's reply relies on the same algorithm from the same prior art reference to support the same legal argument: that Martin discloses the "current minimum" and "future minimum" limitations of the asserted claims.

Indeed, Apple's reply arguments regarding Martin are not the types of arguments that we have previously found to raise a "new theory of unpatentability." For example, in *Ariosa Diagnostics v. Verinata Health, Inc.*, the Board rejected the petitioner's reliance on its reply submissions because the petitioner discussed "previously unidentified portions of a prior-art reference to make a meaningfully distinct contention." 805 F.3d 1359, 1367 (Fed. Cir. 2015). The reply declaration pointed to an embodiment of the prior art that was not discussed in the petition. *Id.* Accordingly, we held that the Board reasonably determined that the reply declaration raised a new argument that was not otherwise addressed in the petition.

Similarly, in *Intelligent Bio-Systems*, we concluded that the reply brief and accompanying declaration exceeded the scope of the petition when the petitioner cited several new non-patent literature references and argued that a POSA would have considered the claim obvious for reasons *other* than those described in the originally relied-upon prior art. 821 F.3d at 1369.

Unlike the above cases, Apple's reply does not cite any new evidence or "unidentified portions" of the Martin reference. Apple's reply brief merely demonstrates another example of the same algorithm to further explain why

Martin discloses the “current minimum” and “future minimum” limitations of claims 6–9. The Board “pars[es] [the petitioner’s] arguments on reply with too fine of a filter.” See *Ericsson Inc.*, 901 F.3d at 1380. It is unreasonable to hold petitioners to such a high standard that, if they choose to rely on one example of an algorithm, they must either discuss all potential permutations of the variables or risk waiving the opportunity to further discuss other relevant examples in their reply. *Chamberlain Grp., Inc. v. One World Techs., Inc.*, 944 F.3d 919, 925 (Fed. Cir. 2019) (“Parties are not barred from elaborating on their arguments on issues previously raised.”).

Further, any ambiguity as to whether Apple raised a new argument on reply is eliminated when we consider whether Apple’s reply arguments are responsive to arguments raised in Andrea’s Patent Owner Response.¹ As we have regularly held, “the petitioner in an inter partes review proceeding may introduce new evidence after the petition stage if the evidence is a legitimate reply to evidence introduced by the patent owner.” *Anacor Pharm., Inc. v. Iancu*, 889 F.3d 1372, 1380–81 (Fed. Cir. 2018).

In its opposition, Andrea argued that Apple’s argument is inherently flawed because Martin requires at least two sub-windows in order to perform one step of the algorithm. Andrea’s response brief devoted at least seven pages to its discussion about why the Martin algorithm, in the context of multiple sub-windows, does not disclose a “future minimum.” J.A. 287–293. Apple’s reply squarely responds to Andrea’s Patent Owner Response. In addition to rebutting Andrea’s arguments addressing the $W = 1$ scenario, Apple argued that Andrea’s multiple sub-window discussion

¹ Notably, neither the Board nor Andrea addressed whether Apple’s reply arguments are responsive to those arguments raised in Andrea’s Patent Owner response. J.A. 15; Appellee Br. 50–65.

“reads non-existent limitations into the claims” and why the algorithm, even in the context of multiple sub-windows, discloses a “future minimum.” J.A. 465–68.

Stepping back a bit of distance persuades us that the Board’s decision to ignore Apple’s responsive arguments to issues raised by Andrea in its Patent Owner Response is not supported as a matter of law; the conclusion that the reply brief constitutes an impermissible new matter is an abuse of discretion.

B. Would a POSA Have Understood the Claim Term “Periodically” to Mean “At Regular Intervals of Time”?

The Court reviews the construction of a claim term by the Board without deference. *Teva Pharm. USA, Inc. v. Sandoz, Inc.*, 574 U.S. 318, 332–33 (2015). Subsidiary factual findings are reviewed for substantial evidence. *Knowles Elecs. LLC v. Iancu*, 886 F.3d 1369, 1374 (Fed. Cir. 2018). When this court reviews the claim construction of a patent claim term in an IPR appeal after the patent has expired, such as in this case, we apply the standard established in *Phillips*, not the “broadest reasonable interpretation.” See *In re CSB-System Int’l, Inc.*, 832 F.3d 1335, 1342 (Fed. Cir. 2016); *Microsoft Corp. v. Enfish, LLC*, 662 F. App’x 981, 984 (Fed. Cir. 2016).

Apple argues that, with respect to the ’627 IPR, the Board erred because it did not construe “periodically” to also mean “from time to time.” Appellant Br. 51.

We disagree. The written description’s only use of the term “periodically” supports the Board’s construction. The written description recites: “The future and current minimum values are calculated continuously and initiated *periodically*, for example, *every 5 seconds* as determined in step 724 and control is advanced to steps 722 and 726 wherein the new future and current minimum are calculated.” ’345 patent, col. 8, ll. 36–38 (emphases added). The written description affirmatively illustrates calculating the

future and current minimum values “every 5 seconds” or within a “regular interval of time.” ’345 patent, col. 8, ll. 36–38.

We recognize that preferred embodiments do not act as claim limitations, but when the invention as claimed covers only the preferred embodiment described in the written description, it is questionable whether a patentee may assert a proposed construction that is broader than the plain language of the claim. See *Phonometrics, Inc. v. N. Telecom Inc.*, 133 F.3d 1459, 1466 (Fed. Cir. 1998) (“Although claims are not necessarily restricted in scope to what is shown in a preferred embodiment, neither are the specifics of the preferred embodiment irrelevant to the correct meaning of claim limitations.”). Here, the written description’s only reference to “periodically” supports the Board’s conclusion that a POSA would have understood this term to mean “at regular intervals of time” rather than “from time to time.”

Apple also argues that the “periodically” term should be construed to mean “from time to time” because the ’345 patent discloses setting the future minimum value to a current magnitude value whenever “the smoothed estimate [of the current magnitude $Y(n)$] is less than the calculated future minimum value.” Appellant Br. 51–52 (citing ’345 patent, col. 8, ll. 36–40). Apple contends that this “smoothed estimate” update is an example of setting the minimum values “from time to time,” and argues that in order “to be consistent” with the intrinsic evidence, “periodically” must be construed to encompass both ways of updating the values. Apple asserts that to adopt the Board’s limited construction would affirm “a claim construction that excludes the preferred embodiment.” Reply Br. 7.

This argument is unconvincing. Even assuming that the ’345 patent addresses different ways of setting the future and current minimum values, Apple conflates the written description’s disclosures of two different methods

of setting minimum values with the separate limitation of setting these values on a periodic basis. In fact, claims 6–9 of the '345 patent do not capture the “smoothed estimate value” method described in the '345 patent—nor do they need to.

As we have held, “[when] the patent describes multiple embodiments, every claim does not need to cover every embodiment. This is particularly true [when] the plain language of a limitation of the claim does not appear to cover that embodiment.” *Pacing Techs., LLC v. Garmin Int'l, Inc.*, 778 F.3d 1021, 1026 (Fed. Cir. 2015) (internal citations omitted). The plain language of the claims-at-issue does not cover the “smoothed estimate” method. Rather, other claims, such as claims 23, 36, and 45 of the '345 patent, which do not include the “periodically” term, discuss a method of determining future minimum values based on “the step of smoothing the estimate of each frequency bin.” *See, e.g.*, '345 patent, col. 12, ll. 4–54. We decline to extend the scope of the “periodically” term beyond the plain text of the intrinsic record.

Nor does the extrinsic evidence help Apple's position. The Board relied on the testimony of Dr. Douglas, Andrea's expert witness, who opined that the Board's construction is the “only . . . definition . . . consistent with the specification of the '345 patent and its use in the particular field of audio signal processing.” J.A. 33. Specifically, Dr. Douglas explained that the “period” of an audio signal is the amount of time it takes for a signal to repeat, and that this amount of time occurs at regular intervals. *Id.*

Moreover, Apple's expert witness admitted during his deposition that, “out of the context of the '345 [patent],” the definition of “periodically” is “at regular time intervals.” J.A. 33. When asked what he perceived “periodically” to mean in the context of the '345 patent written description, Apple's expert simply responded that “all I can do is read

what it says,” which is “that “[i]t’s doing something periodically, for example, every five seconds.” *Id.*

We have regularly held that extrinsic evidence in the form of expert testimony can “provide background on the technology at issue” and “ensure that the court’s understanding of the technical aspects of the patent is consistent with that of a person of skill in the art, or to establish that a particular term in the patent or the prior art has a particular meaning in the pertinent field.” *Phillips v. AWH Corp.*, 415 F.3d 1303, 1318 (Fed. Cir. 2005). Here both parties’ experts offered testimony in favor of the Board’s construction of “periodically” as limited to “at regular intervals of time.” We find that the Board’s subsidiary factual findings with respect to how a person skilled in the art would have understood the “periodically” limitation are supported by substantial evidence. *Knowles Elecs.*, 886 F.3d at 1374.

Accordingly, because the ’345 patent’s written description and the claim language support a construction of “periodically” as “at regular intervals of time” and *not* “from time to time,” and because there is substantial evidence that a person skilled in the art would have understood the term to be limited to “at regular intervals of time,” we conclude that the Board did not err in its construction of the “periodically” term.

C. In the ’627 IPR Proceedings, Did Apple Satisfy Its Burden of Proving That Claims 6–9 of the ’345 Patent Are Anticipated or Would Have Been Obvious?

Apple argues that, even under the Board’s construction of “periodically,” the Board erred in its ’627 IPR finding that Apple failed to prove that claims 6–9 are anticipated or would have been obvious.

We disagree. With respect to its anticipation argument, Apple asserts that Helf discloses the “periodically” limitation because its running minimum estimator sets the

background noise estimate, N_k , to the minimum estimate, M_k , at regular intervals of time. Appellant Br. 58. But substantial evidence supports the Board's findings that Helf's running minimum estimator does not meet the "periodically" limitation. See *Nobel Biocare Servs. AG v. Intradent USA, Inc.*, 903 F.3d 1365, 1375 (Fed. Cir. 2018) ("Anticipation is a question of fact that we review for substantial evidence.").

As described above, Helf discloses two approaches for estimating the background noise in an audio signal: (1) a stationary estimator method; and (2) a running minimum estimator method. Helf's running minimum estimator method is a "back-up" approach. That is, the Helf system does not employ the running minimum estimator method *unless the system cannot employ the stationary estimator approach*. J.A. 966, col. 6, ll. 33–39. Helf explains that the system is set up in this configuration because the stationary minimum estimator is "more accurate," but requires one second intervals of solely background noise. J.A. 966, col. 6, ll. 35–39.

Accordingly, the system employs a "running minimum estimator" in the alternative, which is less accurate but develops background noise estimates in ten seconds "under any conditions." J.A. 966, col. 6, ll. 37–39. The background noise estimate update will not occur unless other conditions are met, such as when an algorithm determines that the difference between M_k and the past background noise estimate exceeds a certain threshold. J.A. 967, col. 8, ll. 10–60.

Under this configuration, Helf cannot satisfy the "periodically" limitation because it does not update the noise estimate M_k or N_k , which Apple alleges is the "current minimum," at regular intervals of time. The running minimum estimator approach only updates the background

noise estimate if the stationary estimator approach is unavailable and if certain conditions are met.

In response, Apple argues that in situations where only the running minimum estimator can operate, the background noise estimate, N_k , is set to the minimum estimate, M_k , “10 seconds after the system starts.” Appellant Br. 58 (citing J.A. 967, col. 8, ll. 33–43). Apple contends that the update that occurs “10 seconds after the system starts” occurs “periodically.” Appellant Br. 58. But this update does not occur “at a regular interval.” It occurs *once*, after the running minimum estimator is activated.

Although Apple insists that the “periodically” limitation also may be met if the Helf system is “power-cycled on and off,” Reply Br. 26, such an argument is unavailing. Not only does the suggestion of “power-cycling” the system defeat the purpose of the “periodically” limitation, but it also requires a user to power-cycle the Helf system at regular intervals because any delay would modify the amount of time between each background noise estimate update. We decline to read such a strained interpretation of the prior art so as to obviate the claimed limitation.

Similarly, we find that the Board did not err in its conclusion that Helf, in combination with Martin, does not disclose the “periodically” limitation. Apple asks us to overrule the Board’s fact-intensive inquiry as to whether a person skilled in the art would have been motivated to combine Helf and Martin to develop a system that updates the current and future minimum values “at regular intervals.” We decline that invitation. *Corning v. Fast Felt Corp.*, 873 F.3d 896, 902 (Fed. Cir. 2017).

Substantial evidence supports the Board’s finding, particularly when Dr. Hochwald’s testimony on the motivation to combine issue consisted of one paragraph of conclusory statements. *See* J.A. 2935–36.

Having determined that substantial evidence supports the Board's finding that a person skilled in the art would not have been motivated to combine Martin with Helf so as to modify the running minimum estimator by adding updates to the background noise estimate, N_k , and the running minimum estimate, M_k , "every ten seconds during operation of the running minimum estimator," we conclude that Helf, in combination with Martin, does not render obvious the "periodically" limitation, as required by claims 6–9 of the '345 patent.²

IV. CONCLUSION

For the reasons stated above, we vacate the Board's findings in the '626 IPR and remand for consideration of the arguments raised by Apple in its '626 IPR reply brief. We affirm the Board's findings in the '627 IPR.

AFFIRMED-IN-PART, VACATED-IN-PART, AND REMANDED

² Apple also argues that the Board's rejection of Apple's proposed modification for Helf, in light of Martin, only relates to claim 6 and not claim 9 because claim 9 specifies updates to the "future minimum value" (as opposed to updates to the "current minimum value"). Appellant Br. 64; Reply Br. 31. Apple misunderstands the Board's reasoning. The Board concluded that a person skilled in the art would not have modified the "running minimum estimator" to update at regular ten second intervals—such a conclusion applies equally to both the background noise estimate and running minimum estimate M_k that are set by the running minimum estimator. J.A. 47–48.